BELLCOMM, INC.
955 L'ENFANT PLAZA NORTH, S.W. WASHINGTON, D. C. 20024

SUBJECT: Test Pattern Projector for the '71 Mars Orbiter Television Camera - Case 710

DATE: September 9, 1968

FROM: P. L. Chandeysson

ABSTRACT

The conceptual design of a test pattern projector for the wide angle television camera of the '71 Mariner Orbiter is described. This projector enables the performance of the camera to be checked throughout the mission by projecting a test pattern through the camera lens onto the vidicon.

(NASA-CR-73568) TEST PATTERN PROJECTOR FOR THE 1971 MARS ORBITER TELEVISION CAMERA (Bellcomm, Inc.) 6 p

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MEMORANDUM FOR FILE

Introduction

One of the objectives of the '71 Mariner Orbiter is to investigate the seasonal changes in the surface markings of Mars known as the wave of darkening. This is to be done by photographing the surface repeatedly for at least three months, and comparing the pictures to detect changes in shape, albedo, and color of the dark areas. This technique assumes that changes in the photometric response of the camera are negligible compared to the changes being measured. Unless the required photometric stability can be demonstrated, some means of checking the camera response during the mission is needed. Even if changes in photometric response appear unlikely, some means of checking the camera performance with a known subject would be useful in detecting other camera malfunctions.

Providing a test pattern painted on an illuminated panel fastened to the spacecraft in view of the camera is one means of checking camera performance. This technique was used with the Surveyor television camera. It cannot be used with the Mariner cameras because they have their focus settings fixed at infinity and cannot focus on a test pattern fastened to the scacecraft. Instead of being focused on the vidicon, light coming from a point on a test pattern two meters from the wide angle Mariner camera would be scattered over a circle 0.42 millimeters, or about 30 resolution elements, in diameter. The blurring would be much worse with the high resolution camera.

Test Pattern Projector Concept

The focus difficulty can be overcome by putting a lens in front of the test pattern. If the distance between the lens and the test pattern is equal to the focal length of the lens, the pattern will appear to be at infinity and will be in focus for a camera set at infinity. Figure 1 shows the conceptual arrangement of a test pattern projector based on this idea and adapted to the Mariner wide angle camera. The lens diameters and focal lengths are shown full size; the physical details have been simplified. The camera, mounted on a two degree of freedom scan platform, is shown looking into the projector which is fixed to the spacecraft. The test pattern is a transparency, much like a lantern slide transparency, but only about 1/2 inch square. It is illuminated from behind by sunlight falling on a ground glass diffusing screen. The image of the test pattern is projected through the lenses and focused onto the vidicon. The test pattern contains grey scales, color patches, and resolution wedges useful in checking the camera performance. It is large enough to fill the field of view of the camera.

The projector is mounted as close to the camera as possible without interfering with the motion of the scan platform. A stray light shield excludes all light from the camera lens except that from the projector. To eliminate the need for accurate alignment of the projector and camera lenses, the projector lens is made smaller in diameter than the camera lens. All of the light leaving the projector lens enters the camera lens even though the optic axes are slightly displaced, as indicated in Figure 1. If the lenses were the same size, any lateral displacement, as might be caused by pointing errors in the scan platform, would cause some of the projected light to be spilled outside the camera lens. Since the amount of light spilled, and hence the brightness of the projected test pattern, would depend on the random misalignment of the lenses, a projector having the same size lens as the camera would not provide a satisfactory check on the camera photometric response.

The projector illumination is furnished by a beam of sunlight about an inch in diameter which is directed onto the ground glass by a small mirror as indicated in Figure 2. This mirror might be attached to a solar panel mounting bracket or any other convenient part of the spacecraft where it can reflect sunlight into the projector. Since the spacecraft attitude is fixed with respect to the sun, the mirror need not be articulated but can be fastened at the proper angle. The beam falls on the ground glass at an angle to the optic axis to prevent direct sunlight from entering the camera if the ground glass should break or the projector were shaken from its mounting. A cylindrical glare shade around the ground glass excludes sunlight reflected from movable parts of the spacecraft such as the high gain antenna. This prevents changes in the illumination of the projector caused by changes in spacecraft configuration. The glare shade also helps protect the ground glass from micrometeoroid damage.

It may be possible to mount the test pattern projector on a fixed bracket and use the scan platform to point the camera into the projector when the test pattern is to be photographed. Since the platform is limited to less than a full turn about the roll axis, the projector might be located at one limit of the scan where it would not interfere with other instruments mounted on the scan platform. If the instrument configuration is such that a satisfactory fixed mounting cannot be devised, the bracket might be hinged so as to clear the instruments. It would then have to be raised into position when pictures of the test pattern are to be taken.

Uses of the Test Pattern Projector

The test pattern projector is primarily a means of monitoring the camera performance throughout the mission. By providing a known subject for the camera to view, it checks the operation of all the camera parts thereby verifying the photographic data. The camera resolution, color response, and veiling glare could be determined from a single photograph of a test pattern containing the necessary designs. Image retention could be measured by photographing the dark sky immediately after photographing the test pattern. Although the brightness of the test pattern is not constant during the mission due to the varying sun-spacecraft distance, this change is predictable; hence, changes in the photometric response of the camera can be determined. The importance of being able to detect changes in photometric response while measuring the wave of darkening is apparent.

The test pattern projector could also be useful in measuring the reflectivity of Mars. The grey scale of the test pattern could be calibrated in terms of reflectivity, and, since the test pattern and Mars are both illuminated by the sun, a comparison of the brightness of Mars to the brightness of the grey scale would indicate the reflectivity of Mars. The intensity of the solar illumination need not be known more accurately than necessary to obtain proper exposure of the vidicon. The Mariner IV camera was used to measure the brightness of Mars in absolute units, and the brightness was divided by the solar illumination to get reflectivity. This method was subject not only to possible changes in the photometric response of the camera but also to the uncertainty in the solar illumination and errors in calibrating the camera.

Paul L. Chandeysson

1014-PLC-jan P. L. Chandeysson

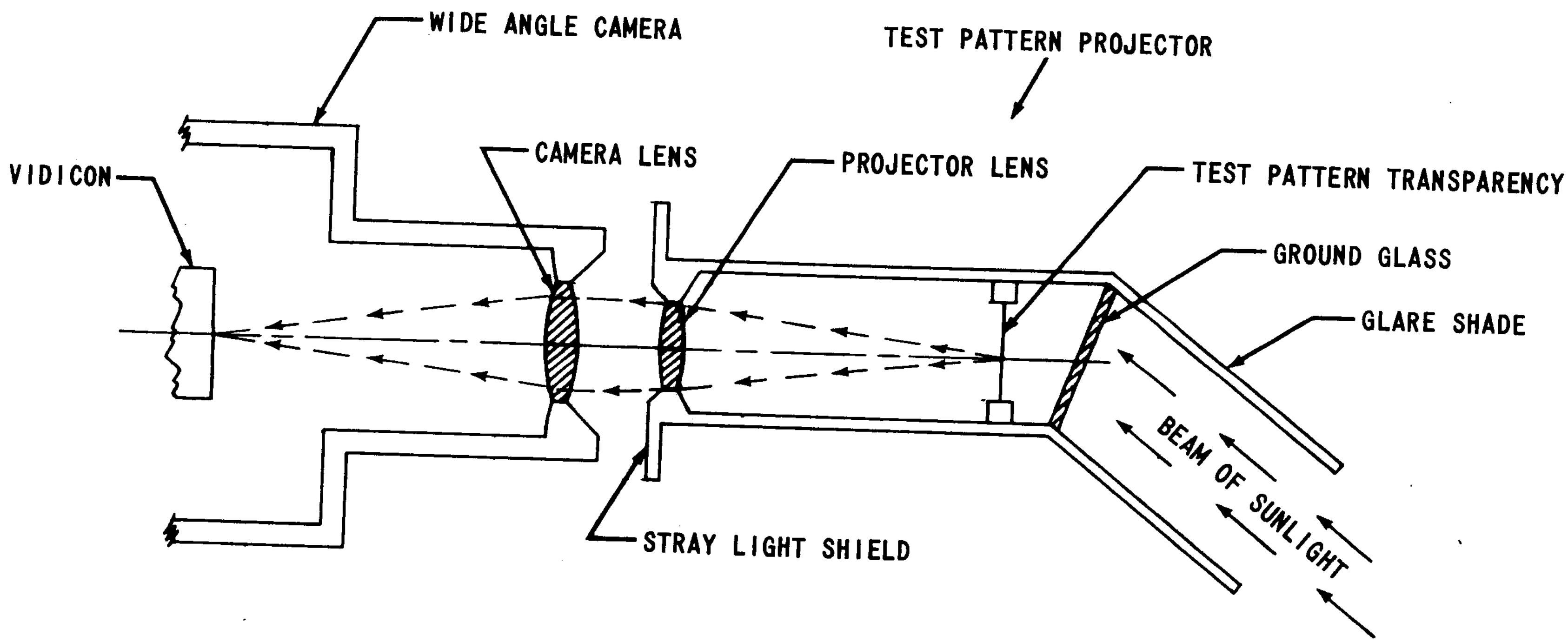

FIGURE 1 - CONCEPTUAL ARRANGEMENT OF TEST PATTERN PROJECTOR

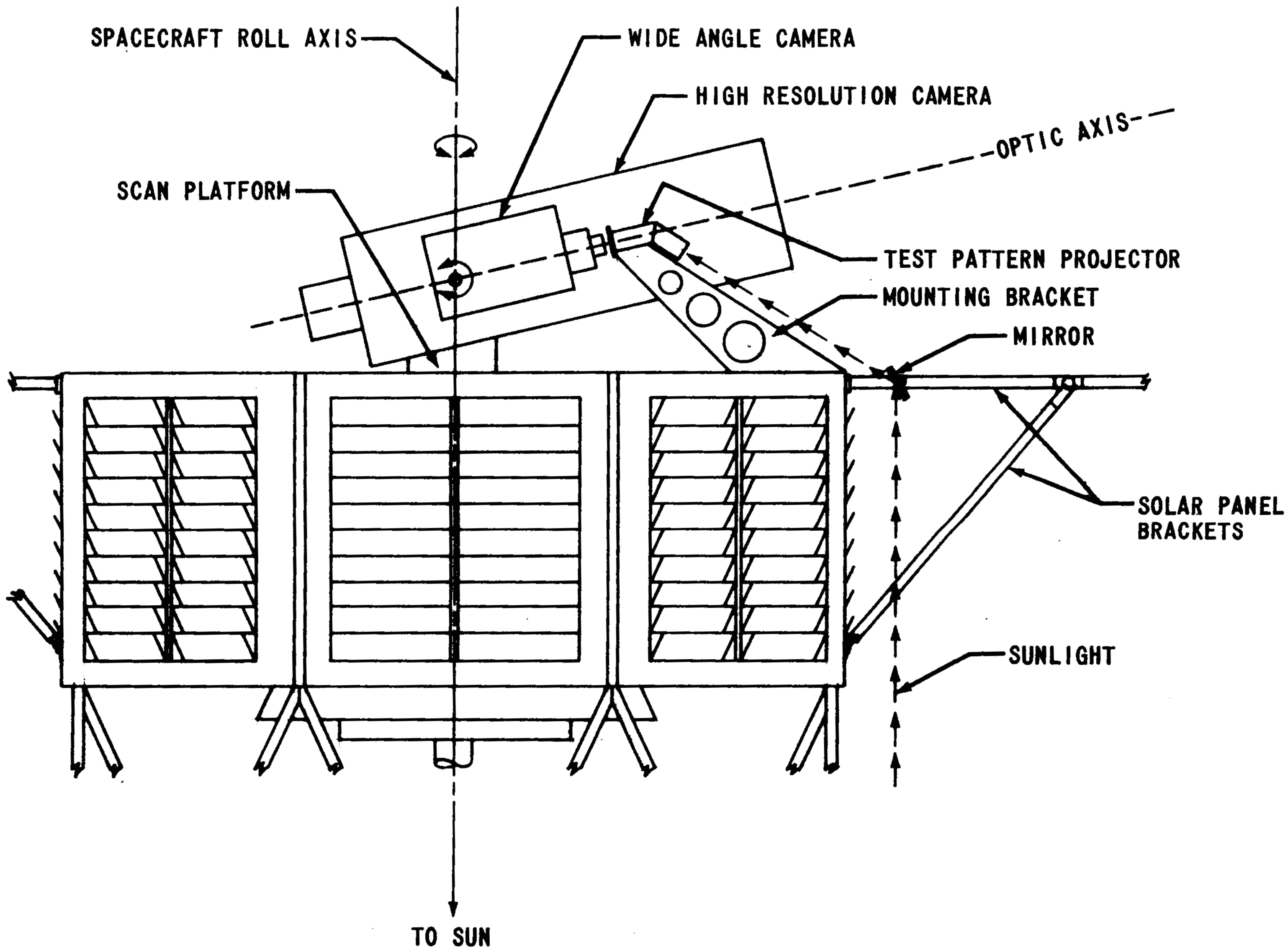

FIGURE 2 - TEST PATTERN PROJECTOR MOUNTED ON MARINER SPACECRAFT

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